11.0 ONSITE TRITIUM IN WATER

For data analysis purposes the sampling locations for tritium in water are divided into seven types. These types of water sampling locations are listed below:

- Potable water or supply wells are the wells that supply water for human consumption. These wells may also be used to supply water for industrial and construction purposes. These locations are sampled quarterly for tritium.

- Industrial wells or non-potable water wells are wells that supply water only for industrial and construction purposes. One industrial well was sampled quarterly, and a second well was sampled for the first quarter then it was taken out of service.

- Potable water end points or water supply distribution points are locations where water is drawn for human consumption. These are typically faucets in buildings such as offices and cafeterias. These locations are sampled quarterly.

- Natural springs are places where ground water comes to the surface. They are used by the fauna of the NTS and sometimes are dry when visited for sampling. These locations are sampled once a year, in July.

- Sewage lagoons are the end points for the several sanitary sewage systems operated on the NTS. Water is lost from these lagoons primarily by evaporation. These locations are sampled quarterly.

- Open reservoirs are man-made water storage ponds. Most are adjacent to wells, but this type also includes the reservoirs that supply the concrete batch plants (Mud Plants) and the Area 23 recreational swimming pool. These locations are sampled once a year, in July.

- Containment ponds are used to contain the effluents from the tunnels. The water in these typically has elevated levels of tritium. Loss of water is primarily by evaporation. These locations are sampled quarterly. The only containment ponds that contain water are at the E Tunnel, the tunnel effluent is grouped with the ponds for convenience.

The names of the sampling locations in each of these type classifications are given in the attachments to this chapter. (Figures, tables, and attachments are located at the end of the chapters.) For a few of the potable water sampling locations samples may be collected from adjacent locations when the primary location is unavailable. For example, when it was time to sample Building 101 in Area 1 for the third quarter sample, the building was locked. The sampler took the sample from an adjacent building, the Area 1 Ice House. A similar situation occurred in Area 12 where Building 12-23, the Medical Aid Station, and the Area 12 Ice House are adjacent buildings. It is known that adjacent buildings are on the same water supply system and are connected to the system in close proximity.

Sampling locations, sample collection dates, measured concentrations, analytic standard deviations, and analytic minimum detectable concentrations (MDCs) for tritium in water appear in Attachment 11.1. Refer to Figure 9.1, in chapter 9, for a map of the Nevada Test Site (NTS) water sampling locations. The numerical format of Attachment 11.1 differs from that of previous chapters. In this attachment, exponential notation is used, while in previous chapters all numbers were scaled by an exponent noted in the headings. For tritium in water, scaling is not reasonable because the data range from 10^{-3} to 10^{-11}.

Tritium samples were collected in 1996 from ten supply wells, two industrial wells, seven potable water sources, nine open reservoirs, seven natural springs, two containment ponds, and nine sewage lagoons. The E Tunnel effluent and Ponds 1 and 2 are considered a single location.

Two analytical procedures are used for tritium analyses. Well waters, both supply and industrial wells, are analyzed using an enriched tritium procedure. The remaining types of waters are analyzed using a conventional tritium procedure. The enriched procedure is capable of measuring substantially lower levels of tritium, and it is more accurate (smaller errors) than the conventional procedure. However, the enriched procedure is also 2¼ times more expensive than the conventional procedure, and the enriched procedure takes about three weeks to perform the analyses, while the conventional procedure typically takes one week. The mean of the MDCs in Attachment 11.1 for the well waters (enriched method) was 1.35×10^{-8} µCi/mL, while the mean MDC for the remaining waters (conventional method) is 7.31×10^{-7} µCi/mL. The mean of the standard deviations for the well waters is 4.06×10^{-9} while the mean standard deviation for the remaining waters is 4.13×10^{-7} µCi/mL. The enriched tritium procedure is used for supply well waters because these supply the potable water for human consumption at the NTS.

An examination of the data in Attachment 11.1 will reveal that almost all the concentration values are less than the corresponding MDC. The exceptions are all the samples from the E Tunnel and the October 7, 1996 sample from Well 5B. The Well 5B sample was only 7 percent above its MDC and may be a false positive result. The concentrations from E Tunnel samples are three orders of magnitude above MDCs and thus show a substantial tritium inventory. Hence the tritium in water results can be divided into two groups of sampling locations based on tritium concentrations: the E Tunnel sampling locations and all other sampling locations.

The data from the other sampling locations will not be statistically analyzed. Concentrations below MDC represent randomness in the analytical procedure rather than providing information about tritium inventories. Forty-six percent of these concentrations are negative; thus, this data is almost centered on zero.

EFFLUENT AND CONTAINMENT PONDS

Tritium in the E Tunnel effluent is known to result from the several nuclear experiments that were preformed within that tunnel. Water that seeps into the tunnel picks up contamination within the tunnel, then exits the tunnel as the effluent and is collected in the containment ponds. The concentrations measured from the containment ponds in 1996 are consistent with historical levels at those locations. A two-way analysis of variance (ANOVA) was used to test for differences between sampling locations and sampling dates. The results are given in Table 11.1. This analysis found no differences; thus, the effluent and containment pond tritium concentrations can be characterized by the descriptive statistics given in Table 11.2, which combine all sampling dates and all locations. The residuals from this ANOVA are normally distributed.

HISTORICAL TRENDS

Detailed reporting of historical trends at all sampling locations would result in an unwieldy document. Instead, two representative locations from each of the types of water sources have been chosen, except that no industrial well was chosen and only one containment pond location was chosen. Tritium in water annual averages are available starting in 1989 and are presented in Table 11.3. When reviewing the data in this table, consider the averages with respect to detection limits. In the units of this table, µCi/mL × 10^{-9}, the detection limit for supply wells is approximately 14, and for the other types of locations, the detection limit is about 730. Prior to 1996, the sensitivity of the analytical procedure was reported as a detection limit rather than as a MDC; thus, for discussing historical data, it is appropriate to use the detection limit. Also, it is important to note that prior to 1991 the enriched tritium method was not used to analyze water from supply wells, rather the conventional method was used. The industrial wells were analyzed using the conventional method through 1994, then beginning in 1995, the enriched method was used.

Table 11.3 clearly shows the effect a source of tritium has on the E Tunnel effluent. The remaining sampling locations are below detection limits for all years except for the supply wells in 1991 through 1993.

CONCLUSIONS

Except for the containment ponds, the 1996 tritium in water concentrations are below the individual minimum detectable concentrations. Measurable levels of tritium are expected in containment ponds, since these contain effluent from nuclear events within the tunnels.

Table 11.1 Two-Way ANOVA on Tritium in Effluent and Containment Ponds Response Variable is 1996 Tritium Concentration (µCi/mL × 10^{-6})

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-Value	P-Level
Sample Date	3	40711	13570	1.31	0.414
Location	1	8712	8712	0.84	0.426
Error	3	31015	10338		
Total	7	80438			

```
Sample                          Individual 95% Confidence Intervals
  Date            Mean          --------+---------+---------+---------+---
02/07/96          862           (---------------*--------------)
05/30/96          913                (--------------*--------------)
07/25/96          1030                     (---------------*--------------)
10/31/96          1022                     (--------------*--------------)
                                --------+---------+---------+---------+---
                                       750       900      1050      1200

                                 Individual 95% Confidence Intervals
Location          Mean          ----+---------+---------+---------+-------
Effluent          924           (---------------*----------------)
Ponds             990                  (---------------*---------------)
                                ----+---------+---------+---------+-------
                                   800       900      1000      1100
```

Table 11.2 Descriptive Statistics for 1996 Tritium in Effluent and Containment Ponds

Number of Samples = 8
Mean = 9.57×10^{-4}
Standard Deviation = 1.07×10^{-4}
Median = 1.01×10^{-3}
Minimum = 7.76×10^{-4}
Maximum = 1.05×10^{-3}
Median MDC = 7.40×10^{-7}

Table 11.3 Historical Annual Averages for Tritium in Water at Representative Sampling Locations

Table Data is in Units of µCi/mL × 10^{-9}

Location	1989	1990	1991	1992	1993	1994	1995	1996
Well UE-5C	20	-45	64	3	67	2	-4	-4
Well J-13	120	70	21	48	18	0	-1	-1
Area 6, Cafeteria	52	89	-28	18	60	-11	154	-52
Mercury Cafeteria	75	210	-38	31	29	49	23	63
Area 2, Mud Plant	200	151	121	76	22	102	74	74
Well J-11 Reservoir	75	21	19	60	59	-133	91	183
Cane Spring	110	-10	394	-27	17	-180	430	114
Reitman Seep	167	29	158	102	-81	50	0	97
Area 12, Sewage Pond	100	423	352	151	121	-11	56	4
Area 23, Sewage Pond	267	185	-47	105	-80	67	13	-20
E Tunnel Effluent	993480	1475000	2175000	2000000	1800000	-	827000	923750